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IMPORTANT INSECTS WHICH MAY AFFECT THE HEALTH OF MEN OR ANIMALS ENGAGED IN MILITARY OPERATIONS.

(Prepared in the Bureau of Entomology.)

INTRODUCTION.

A number of the most serious infectious diseases are carried by insects. Of these, typhus fever, malaria, yellow fever, and bubonic plague are conveyed only or chiefly by the bites of insects. Other diseases, such as typhoid fever, dysentery, and other affections of the intestines, while also acquired in other ways, are frequently conveyed by flies or other insects which carry the causative germs from excrement or other body discharges to food. Entirely aside from transmission of diseases, many insects are of importance on account of the annoyance and loss of sleep which they cause. A number of species are also of importance on account of the injury they do to military stores, especially foods.

In the southwestern part of the United States are to be found many species of noxious insects. In view of the fact that the United States is mobilizing troops in that portion of the country, the following brief statements regarding the control of insects which may affect the health of the troops and their animals have been collected. As far as possible advantage has been taken of the recent advances which have been made in the European armies in the control of insects.

INSECTS WHICH MAY CARRY OR CAUSE DISEASES BY CONTACT WITH FOOD AND WOUNDS.

Many of the bacterial diseases are very readily carried by insects, especially by the house fly and other flies of similar habits. Among these diseases are typhoid and para-typhoid fevers, dysentery, and diarrhœa.

A distinct type of disease caused by the presence of insects in the body is known as myiasis. Briefly, myiasis is the occurrence of fly maggots in the body of persons or animals. There are several types according to the location of the larvæ. Intestinal myiasis is caused by eating larvæ of insects in food. Dermal myiasis consists of the occurrence of fly maggots in wounds or in boil-like swellings caused by the maggot itself. Another form of myiasis is caused by maggots in the various body openings and is usually a serious matter.

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HOW THE HOUSE FLY CARRIES DISEASE.

The habits of the house fly render it dangerous to the health of man, especially in temporary or semipermanent arrangements of camp life where there is a large amount of excreta and refuse with only primitive or makeshift methods of disposal. House flies not only breed in and feed on these accumulations of excrement and refuse, but, as everyone knows, they also frequent kitchens and mess tents. They will pass from excrement to food and vice versa. The great importance of this insect in connection with military operations was clearly shown during the Spanish-American War.

A special board of medical officers, consisting of Reed, Vaughan, and Shakespeare, investigated the subject and made a most noteworthy report, from which the following is quoted:

> We are satisfied that the evidence furnished in our studies, to be detailed later, is sufficient to show beyond reasonable doubt that the most active agents in the spread of typhoid fever in many of the encampments in 1898 were flies. The reasons for coming to this conclusion will be given in detail later, but may be summed up here as follows:
>
> (1) The latrines contained fecal matter specifically infected with typhoid bacillus.
>
> (2) Flies alternately visited and fed upon this infected fecal matter and the food in the mess tents. More than once it happened, when lime had been scattered over the fecal matter in the pits, that flies with their feet covered with lime were seen walking over the food.
>
> (3) Typhoid fever was much less frequent among members of messes who had their tents screened than it was among those who took no such precaution.
>
> (4) Typhoid fever gradually died out in the fall of 1898 in the encampments at Knoxville and Meade with the disappearance of the fly, and this occurred at a time of the year when in civil practice typhoid fever is generally on the increase.

HABITS OF THE HOUSE FLY.[1]

The eggs are laid in horse manure, human excrement, pig manure, and to a less extent in other manure, in decaying grain, moist bran, moist mixtures of hay and grain from feed troughs of animals, in excreta-soiled straw, paunch contents from slaughtered animals, decaying kitchen refuse, and rotting fruits and vegetables; in excreta-soiled paper and rags, and in ensilage.

Each female fly may lay as many as 120 eggs at one time, and as a rule several flies will deposit in the same spot, so that the eggs are usually found in clusters or nests, in cracks and crevices of the manure or other material. The size and appearance are well illustrated in figure 1.

The moisture and heat of the fermenting substance in which the eggs are laid cause them to develop rapidly, and within 10 to 24 hours the maggots hatch out. These maggots feed in the manure or other material, keeping below the surface. If conditions are favorable, they reach full size within 4 days. Figure 2 shows them at this stage. When full grown and fully fed, they migrate from their

[1] *Musca domestica* L.

feeding ground in search of a favorable place in which to pass the pupal or resting stage. They will often congregate at the edges of manure piles near or in the ground, or they may crawl away from the pile and pupate in the ground or in loose material under the edges of stones, boards, etc. Then the maggot contracts and its old skin forms a barrel-shaped case with rounded ends within which the adult fly is gradually formed. This pupal or resting stage is shown in figure 3. The duration of this stage is from 3 to 10 days and the total time from laying of eggs to the emergence of the adult fly is from 8 to 15 days.

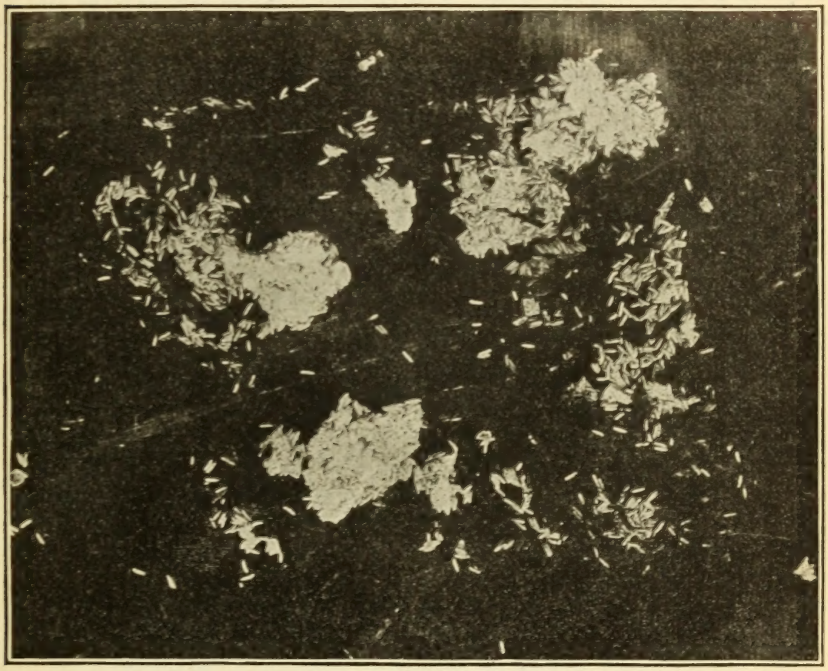

FIG. 1.—Eggs of the house fly. About natural size. (Newstead.)

PRACTICAL CONTROL OF THE HOUSE FLY AND INSECTS BREEDING IN MANURE AND LATRINES.

The disposal and treatment of manure.—In the arid region along the Mexican border perhaps the best way of disposing of manure is the following method adopted by Lieut. H. C. Michie:[1]

Spread the manure evenly not to exceed 4 inches in depth in such a manner that the wagons will not have to run over it after it has once been spread. Burn when dry enough (in about two days). Use space again. It is important to have the surface uniformly covered, as it will be easier to burn.

A slight modification of this method[2] has been used in certain camps. This consists in dumping the manure from the tail of wagons

[1] The Military Surgeon, v. 35, p. 132–148. 1914.
[2] See Miller, Military Surgeon, v. 33. December, 1913.

in narrow windrows about 8 feet apart. After drying for a few hours each windrow is spotted with oil at intervals of 6 feet on the windward side and fired. The next day the wagons straddle the windrows and dump the manure on the ashes of the previous day's burning. It is necessary to rake the windrows in narrow rows to prevent burning the feet of the wagon animals.

Where the accumulation of manure is too great or weather conditions render such a method impracticable, the following method might be tried:

A long space about 12 feet wide should be marked off and all manure hauled to that area. The loaded wagons travel over the top of previous accumulations; in this way a large but compact and well-

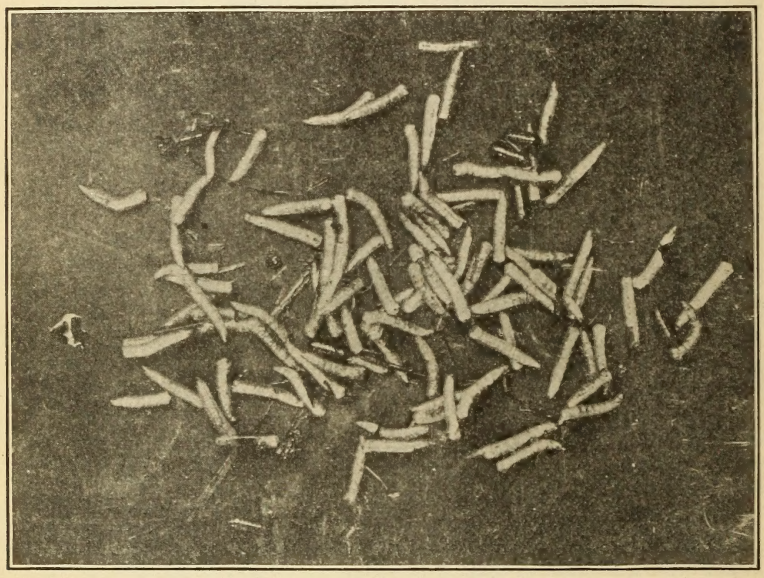

FIG. 2.—Larvæ, or maggots, of the house fly. About natural size. (Newstead.)

shaped heap is built up. Driving over the top of previous accumulations packs it down tightly, and thus renders it unfavorable as a place for the breeding. If in addition to this the surface is treated every day or two with powdered borax, at the rate of three-fifths of a pound per 8 bushels of manure, the fly breeding will be very greatly reduced, if not entirely prevented.

Another method of controlling the flies in heaps of manure is to spray the surface thoroughly with a solution of sodium arsenite and sugar made according to the following formula: One pound sodium arsenite in boiling water; add this to a solution of 10 pounds of brown sugar in 10 gallons of water. This operates against the adults, which are attracted and poisoned by the sweetened mixture. This spraying should be repeated at frequent intervals, so that there will be a supply of the sweetened poison on which the flies may

feed. Such a method is effective in killing the flies before they have an opportunity to deposit eggs.

Another method of disposing of manure is by means of the so-called "maggot traps." This method is not adapted to temporary camps, but in more or less permanent establishments and where the manure is to be used as a fertilizer it is the best that can be used. The principle of the maggot trap is based on the habits of the larvæ, which crawl away from moist manure when about to pupate, or go into the resting stage. In one type the manure is placed on a slatted platform which stands over a concrete basin containing water covered by a film of oil. When the maggots are full grown they

FIG. 3.—Pupæ of the house fly. About natural size. (Newstead.)

crawl away from the manure and drop into the water and drown. The construction of this device will be clear from the accompanying illustrations (figs. 4, 5).

The disposal and treatment of garbage and kitchen refuse.—Kitchen garbage also proves to be a good medium for breeding flies, and it is important to dispose of it completely. All solid garbage should be burned immediately, and liquid garbage should be run into pits and covered with oil or liberally treated with borax. If the liquid portion of the garbage is mixed with the solid it will be possible to dispose of it by burning it if oil is added. If it is not burned it should be treated with borax and buried.

For disposing of all liquid as well as solid garbage, the incinerator evolved by Capt. William L. Guthrie is found satisfactory and

economical. (See the Sanitation of the Second Division, United States Army, at Texas City and Galveston, Tex., March 1 to July 31, 1913, Military Surgeon, December, 1913.)

Treatment of latrines.—Latrines should be fitted with sanitary fly-tight covers, and may be treated in one of two ways. One method which has been used is to cover the pit with hay sprinkled with oil and burn out at frequent intervals. Another method which might be used would be to treat liberally with powdered borax or crude

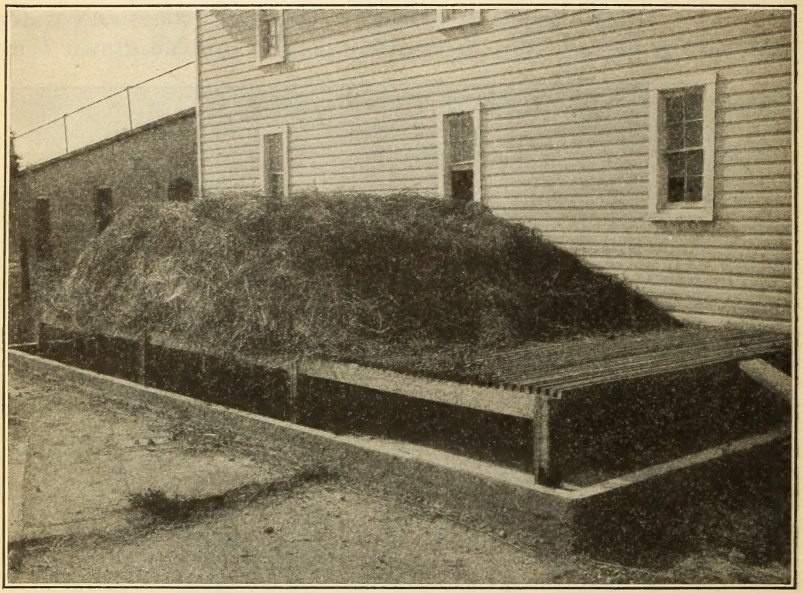

FIG. 4.—A maggot trap for house-fly control. View of the maggot trap, showing the concrete basin containing water and oil in which larvæ are drowned, and the wooden platform on which manure is heaped. (Hutchison.)

carbolic acid every few days, finally filling the pit with earth and constructing new ones as needed.

In connection with the reduction of flies in camps, attention must be given to possible sources of flies in the surroundings of the camp. Some inspection should be made of all places within 1,500 yards of the camp, and sanitary measures instituted. Under some conditions the house fly travels distances greater than 1,500 yards, and if flies are still prevalent after the operation of the foregoing control measures it would be well to make inspection still farther from the camp with the view to discovering and eliminating breeding places.

Screening.—This is a valuable measure when screens are constructed well and kept in good repair. It should be supplementary to attack against the breeding places.

Trapping.—One of the best fly traps is the conical hoop of the design shown in the illustrations (figs. 6, 7). It is a cylinder 24 inches

high and 18 inches in diameter. Inside of this and attached to the base is a cone 22 inches high with an opening at the apex of about an inch in diameter. Traps of this kind can be made from wooden barrel hoops, barrel heads, and lath as the framework for the necessary screening wire.

The most effective baits for such traps are waste beer, a mixture of cheap molasses and water, or banana and milk, or a sirup made of brown sugar, 1 part, plus water, 4 parts. A mixture of equal parts of brown sugar, cheese, and water is also good bait if it has been standing a few days. A large number of traps should be in operation at the same time, placed in all locations where flies are seen to congregate. The insects may be killed in the traps by applications of hot water or with sulphur fumes. It is necessary to empty them at frequent intervals and to keep the bait renewed.

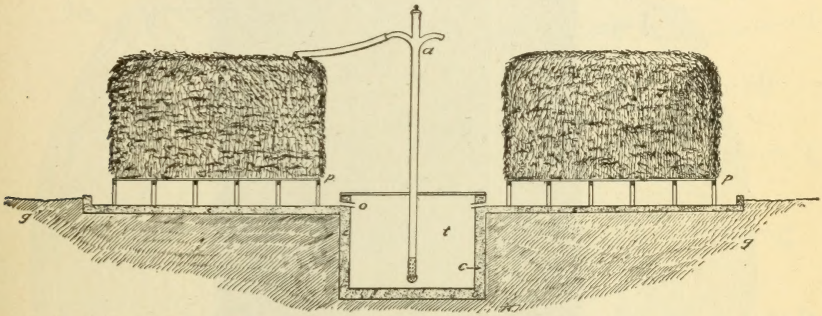

FIG. 5.—Imaginary cross section of an arrangement suggested for trapping maggots, for use where manure production is large: *a*, Pump; *c*, concrete floor and walls of cistern; *o*, outlet pipes leading from floor of maggot trap to cistern; *p*, platform maggot trap; *t*, cistern for liquid manure; *g*, ground level. (Hutchison.)

Poisoned baits.—One of the simplest means of destroying adult flies is by use of poisoned baits. A solution of formalin (one-half teaspoonful) in sweetened water or milk (1 ounce) is an excellent poison. It should be placed in shallow dishes with a crust of bread, which affords increased surface for the poison and place for the flies to alight while feeding. Such dishes should be placed wherever flies collect. Another poisoned bait is made according to the following formula: Dissolve 1 pound sodium arsenite in boiling water; then add it to a solution of 10 per cent of brown sugar in 10 gallons of water. This may be exposed in dishes in the same way, or spread over the surface of manure piles and all places where flies are seen feeding.

In the use of such baits great care should be taken to avoid the accidental poisoning of men.

COCKROACHES.

Cockroaches are among the commonest insects found associated with food, especially where the food is being handled in large quantities. One of the most effective means of ridding premises of roaches is dusting with commercial sodium fluorid, either pure or diluted one-

half with some inert substance, such as powdered gypsum or flour. With the use of a dust gun or blower this substance can be thoroughly dusted into the runways and hiding places of the roaches. Other powders which have proved to be more or less successful are borax, used either pure or mixed with pulverized chocolate in the proportion of 1 part of borax and 3 parts of chocolate; pyrethrum; or a phosphorous paste, which is a sweetened flour paste containing 1 to 2 per cent of phosphorus.

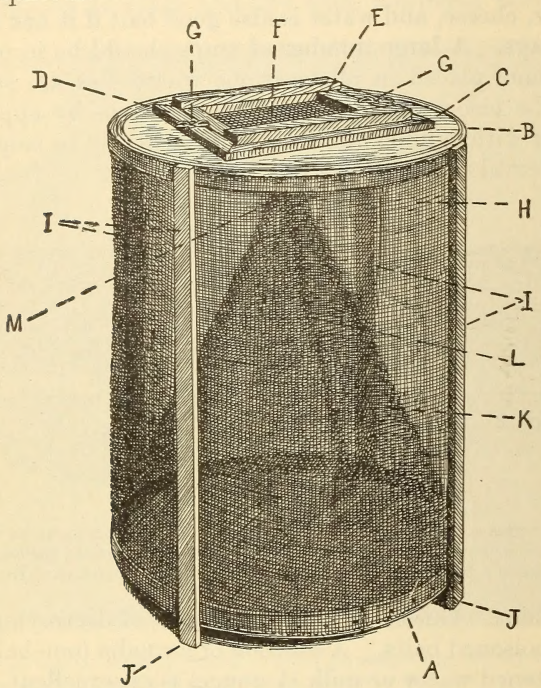

FIG. 6.—Conical hoop flytrap, side view. *A*, Hoops forming frame at bottom. *B*, Hoops forming frame at top. *C*, Top of trap made of barrel head. *D*, Strips around door. *E*, Door frame. *F*, Screen on door. *G*, Buttons holding door. *H*, Screen on outside of trap. *I*, Strips on side of trap between hoops. *J*, Tips of these strips projecting to form legs. *K*, Cone. *L*, United edges of screen forming cone. *M*, Aperture at apex of cone. (Bishopp.)

INTESTINAL MYIASIS IN MAN.

The insect most often found in the intestines of man is the maggot of the cheese fly (*Piophila casei* L.), usually called the cheese skipper. This insect deposits its eggs on old cheese, ham, bacon, and other fats. The maggots of the house fly and of other flies of similar habits are occasionally taken into the body by man. Blowfly maggots sometimes find their way into the intestines with meat. Fly larvæ breeding in fruit and vegetables are also occasionally swallowed. Precautions against intestinal myiasis consist of the avoidance of infested food, concerning which suggestions are given on subsequent pages.

DERMAL MYIASIS.

Various species of flies are attracted to the body by wounds, discharges from the ear, catarrhal affections, or even by offensive breath or watering of the eyes. They lay their eggs or deposit living maggots in such places. When the attack is in the nose, satisfactory treatment is by the use of a spray of chloroform water or a solution of chloroform in sweet milk (10 to 20 per cent), followed by sprays of mild antiseptics. Surgical treatment is sometimes necessary.

The so-called screw-worm fly (*Chrysomyia macellaria* Fab.) has habits similar to those of the blowflies in that it breeds in dead animal

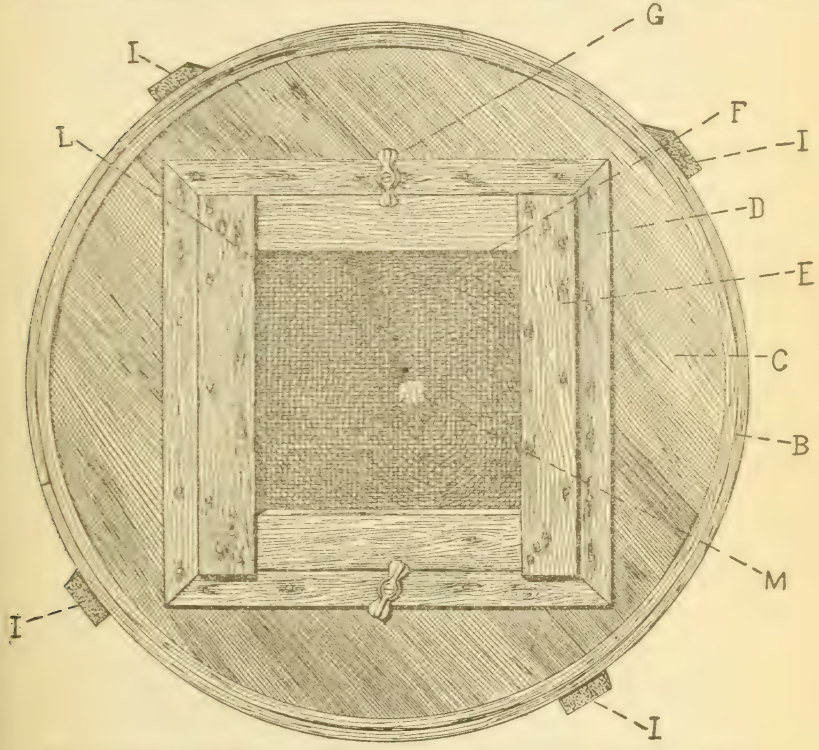

FIG. 7.—Conical hoop flytrap, top view. Letters designate parts as in figure 6. (Bishopp.)

matter. In addition, however, it often lays its eggs in living flesh, unprotected wounds, and open sores of men and animals as well as the body openings. The nostrils, especially when there is bad breath or fetid discharge, are frequently selected for this purpose. In this habit lies the very real danger to man. The attack is often insidious and the victim unaware of the presence of the eggs until the maggots have hatched and penetrated deep into the tissues. When the nostrils are invaded, only prompt and heroic measures will prevent a fatal termination. Such cases are not infrequent, and as this fly is the most abundant blowfly in many southern localities, sleeping unprotected in the open during the day should be carefully avoided.

This fly is about the size of the common bluebottle blowflies and of a metallic blue or green color. It may be readily distinguished by three dark stripes running down the back between the wings.

In tropical America an annoying parasite of man is the maggot of the Dermatobia fly. This maggot develops under the skin of a person or animal, giving rise to a boil-like swelling, causing itching and pain.

INSECTS WHICH CONVEY DISEASE BY BITES.

Some of the most dangerous diseases of the Tropics are conveyed by the bites of blood-sucking insects. The diseases of this kind most to be guarded against in the Western Hemisphere are typhus

FIG. 8.—A malaria mosquito, *Anopheles quadrimaculatus:* Male at left and female at right. Greatly enlarged. (Howard.)

fever, carried by lice; malaria, yellow fever, and dengue or break-bone fever, carried by mosquitoes; and bubonic plague, carried by fleas from rats to man, and from man to man.

Mosquitoes can develop only where there is water. The female lays eggs and from these eggs hatch little worm-like larvæ called "wrigglers" or "wiggle-tails" which live in the water. These larvæ, although living in water, breathe air which they obtain by rising to the surface at frequent intervals and bringing the breathing tube at the hind end of the body in contact with the air. When full grown they transform into pupæ, or "tumblers." These are very stout and usually of dark color; they float at the surface, but when alarmed rapidly go to the bottom. After an interval of 2 or 3 days the pupa splits open along the back and the full-sized mosquito issues from it.

MALARIA MOSQUITOES.

There are several kinds of mosquitoes that convey malaria, all belonging to the genus Anopheles (figs. 8 to 12). They do not differ greatly in appearance from other mosquitoes. In most Anopheles the wings are distinctly spotted. These mosquitoes have very slender legs and the body does not have the "humped-back" appearance of other mosquitoes. When resting upon a wall or other surface, or when biting, the body is tilted—that is, the tail end slants away

FIG. 9.—A malaria mosquito, *Anopheles punctipennis:* Female mosquito. Greatly enlarged. (Howard.)

from the surface upon which the mosquito is resting. The malaria mosquitoes usually bite late in the evening and early in the morning, but in shady places and when hungry they will bite in full daylight.

They commonly breed in springs or in water holes in stream beds, and frequently even in running streams, along the edges, where the current is less rapid and where they find shelter among vegetation or obstructions. The larvæ are easily recognized by the fact that they float horizontally at the water surface, only diving down when thoroughly alarmed.

THE YELLOW-FEVER MOSQUITO.[1]

Yellow fever can be transmitted only by the bite of one kind of mosquito (figs. 13 to 15). It is a house mosquito and is not found away from human habitations. It may be readily recognized by its striking ornamentation. The back, just behind the head, bears a lyre-like silvery pattern and the legs and hind part of the body are banded with white in a conspicuous manner. This mosquito is active chiefly during the bright part of the day, and particularly in the early part of the afternoon.

FIG. 10.—Eggs of a malaria mosquito, *Anopheles quadrimaculatus*, resting on surface of water. Highly magnified. (Howard.)

The yellow-fever mosquito breeds in water in receptacles in or near houses, such as water jars, rain barrels, cisterns, rain troughs, discarded tins and bottles, etc. It does not breed in natural collections of water, such as swamps, pools, or rain puddles. The position of the larva when at the water surface to take in air is very characteristic. The body hangs nearly straight down, while in many other mosquito larvæ the body is held more obliquely.

THE HOUSE MOSQUITO,[2] TRANSMITTER OF DENGUE FEVER AND FILARIASIS.

This dull-colored mosquito is also confined to the vicinity of houses, as is the yellow-fever mosquito. It is active at night and very annoying, not only by its bite but also by its song. It breeds in the vicinity of habitations and the larvæ are to be found in rain barrels and other receptacles, as well as ditches, gutters, or even streams when polluted by sewage. In fact it prefers foul water, and highly polluted water induces it to multiply enormously. Under these conditions it may quickly become a serious pest. The larvæ may be distinguished from those of the yellow-fever mosquito by the much longer breath-

FIG. 11.—*Anopheles quadrimaculatus:* Larva in resting position. Greatly enlarged. (Howard.)

[1] *Aedes calopus* Meig.

[2] *Culex quinquefasciatus* Say.

ing tube at the tail end, which, in the natural position of the larvæ, is uppermost, and, furthermore, by the position of the body, which hangs downward at an angle of about 45 degrees, instead of nearly straight down.

OTHER MOSQUITOES.

Mosquitoes occur in greater or less abundance nearly everywhere, there being particular kinds adapted to special conditions. Their abundance in a given locality, in spite of the fact that water is necessary for their development, is by no means always in proportion to the amount of standing water present. In fact, one often finds mosquitoes abundant and annoying in very dry regions with little or no water. These mosquitoes have developed in temporary pools produced by heavy rains. Great numbers may develop from such pools at one time, and as such mosquitoes are rather long-lived it frequently happens that they are in evidence long after the puddles that gave them birth have dried out.

MOSQUITO CONTROL.

To be effective, mosquito-control measures must be directed against mosquito breeding. Protection of the individual by means of nets, screening of houses and tents, the use of repellent substances, etc., must be regarded as purely supplementary. They should never be relied upon exclusively unless the temporary nature of the camp or the size and character of the breeding area render radical methods impracticable.

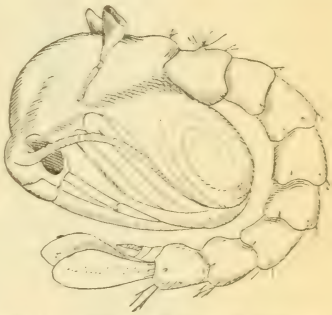

FIG. 12.—Pupa of a malaria mosquito, *Anopheles quadrimaculatus*, in resting position. Greatly enlarged. (Howard.)

Dry regions, in spite of the dryness of climate and aridity of soil, frequently afford many opportunities for mosquito propagation. Where breeding places occur in such regions their importance is increased by the fact that the water forming them is sought by travelers or settlers.

It can not be too strongly emphasized that a very few small and apparently unimportant breeding places, artificial or otherwise, will, if neglected, produce enough mosquitoes, often of disease-carrying species, to infest seriously a whole community. Among the most productive situations occurring in the vicinity of settlements are mudholes in roads (especially if not constantly traversed), ruts, the hoof prints of animals, and depressions in vacant lots, particularly in the presence of vegetation. The ponds or tanks used for the storage of water pumped by windmills from artesian wells and ordinary wells, especially if not too deep, are excellent breeding places. It should

be repeated that refuse containers of all kinds, barrels for containing rain water, the drinking vessels of poultry, as well as watering troughs, cisterns, etc., are favorite resorts of the yellow-fever and house mosquitoes. In fact, larvæ frequently occur in such small collections of water when none are to be found in the larger and more obvious bodies.

Running streams, if not too rapid, especially if the banks are overhung by grasses or other vegetation to afford protection, or if there are hollows and indentations along the banks beyond reach of the current; swamps or bogs in the small meadows which are often found along the course of mountain streams; hollows and water holes in arroyos or gullies, otherwise dry; and pot holes in the rocks of stream beds, must all be included among the breeding places of mosquitoes.

FIG. 13.—The yellow-fever mosquito (*Aedes calopus*): Adult female. Much enlarged. (Howard.)

Methods of mosquito control may be either permanent or temporary. Permanent control is effected by means of drainage, which renders the area involved permanently incapable of retaining water a sufficient time for the growth and transformation of the young mosquitoes. Temporary control aims at eradication of mosquito breeding for the time only, and is usually effected by means of oiling of water surfaces, sometimes with the addition of the cutting of vegetation, grass, or bushes, which afford shelter for the adult mosquitoes during their passage from the breeding place to human habitations. Where the vegetation is dense and the cover afforded mosquitoes is good, the growth should be cleared for a radius of not less than 1,000 feet. However, it is difficult if not impossible to specify exactly an effective distance, as this will vary with the conditions and the species of mosquitoes involved. A narrower radius than 1,000 feet may be

effective, while under some circumstances a much broader one may be required. Often a small amount of ditching will effectively drain a relatively large breeding area.

Crude oil, not too heavy to spread evenly upon the water surface, will be found the most effective under service conditions. The object is the formation of a fairly heavy film, as nearly as possible unbroken, over the entire area treated. The larvæ and pupæ, unable to reach the air, are soon smothered.

If it is found that the oil available is of too heavy a quality to spread readily, the addition of kerosene or a little caustic soda will usually render it "lighter." A miscible larvicide, of which there are several upon the market, has advantages for some situations, as it permeates the body of water to which it is applied and does not drift with the wind, a fault the crude oil possesses. A knapsack spray pump is the best means of applying the oil, but in its absence an ordinary garden watering pot with spraying nozzle is good, while a pail and tin cup will be useful in an emergency.

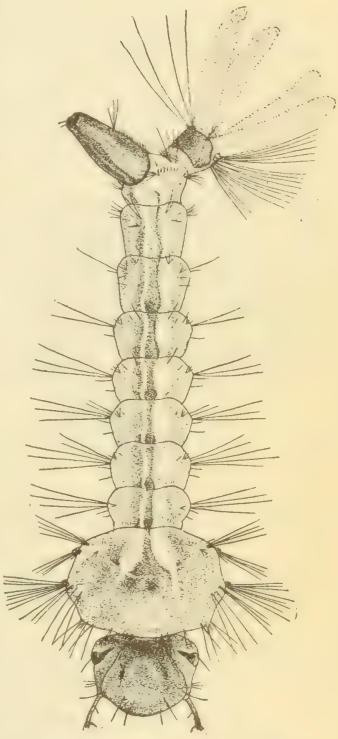

FIG. 14.—Larva of the yellow-fever mosquito in resting position. Much enlarged. (Howard.)

In the matter of receptacles of water containing the larvæ of house or yellow-fever mosquitoes, the simple expedient of emptying the contents is sufficient, but care should be taken to see that they are thoroughly drained, or even rinsed if of the nature of water barrels or water jars which are to be refilled, as larvæ will often be held in the drops of water clinging to the sides. Old tins and bottles, etc., should be buried, or at least made incapable of holding water. Water barrels, tanks, etc., should be effectively screened against mosquitoes, this screening to be protected by heavy wire netting. A wooden spigot may be placed near the bottom of the former to render unnecessary the constant removal of the screen.

In a dry or semi-arid region, in which water is often scarce and valuable, the contents of infested water barrels may be strained through cloth and replaced. When for the same reason the contents of breeding pools is required for various uses, no remedy can be suggested, and protection of human beings by nets, etc., must be resorted to. To exclude the yellow-fever mosquito, wire screening must have at least 18 meshes to the inch.

Repellents may consist of various compounds or simple substances. These have been recommended: Oil of pennyroyal, oil of citronella, oil of peppermint, or a mixture of oil of citronella, 1 oz.; spirits of camphor, 1 oz.; and oil of cedar, ½ oz.

Any of the foregoing pungent oils or spirits, combined in proportions of a few drops to the half ounce of vaseline or lanoline, can be used with increased effectiveness, since the grease holds the odor in suspense, whereas the oil or spirits alone would evaporate in a short time.

SUMMARY OF MOSQUITO-CONTROL MEASURES.

Avoid the bites of mosquitoes as essentially dangerous, especially in districts where malaria is known to exist.

Use nets or bars when the presence of mosquitoes is even suspected, as the bites of some dangerous kinds attract little attention on account of their comparative painlessness.

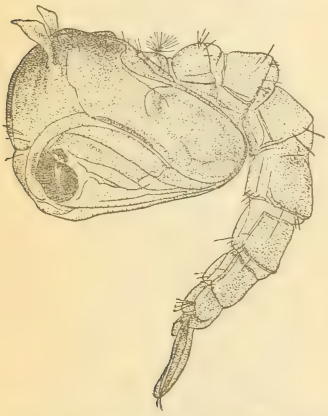

FIG. 15.—The yellow-fever mosquito: Pupa. Much enlarged. (Howard.)

Look for the larvæ of yellow-fever and dengue (domestic) mosquitoes in water barrels, water jars, and all water-containing receptacles.

Look for the larvæ of all malaria-carrying mosquitoes in all natural collections of water, no matter how small and seemingly insignificant. The smaller breeding places are often the most important.

Empty, destroy, or screen all receptacles and drain, oil, or fill the natural collections. Cut or clear off tall grass and bushes, if at all thick, for 1,000 feet about camps and settlements if breeding places exist beyond.

Use crude petroleum on water of active or suspected breeding places and see that the surface is evenly covered.

Use saucer, cup, or dipper in searching the margins of suspected spots for larvæ; they are not readily discovered otherwise. Skim rather than scoop.

Use as repellents oil of pennyroyal, oil of citronella, oil of peppermint, or the mixture mentioned above.

LICE.

Pediculus corporis Deg., *P. humanus* L., *Phthirius pubis* L.

Among the most important pests of Mexico and the border sections are the body louse, the head louse, and the crab louse.

The body louse is by far the most important species on account of the facility with which it spreads and the difficulty with which it is

controlled. Furthermore, this species has been proved to be the carrier of typhus fever, which is prevalent in a considerable portion of Mexico. Moreover, its bites are very irritating and sometimes become infected, especially when the infested person scratches. This species is found on the body only during its short feeding periods. At other times it is to be found in the clothing. All articles of clothing, even the shoes and headgear, become infested, particularly when the lice secrete themselves in seams, folds, and crevices, and it is there that they deposit their eggs. Beds and bedding become infested with the body lice, and where they have multiplied excessively even the crevices of walls, floors, and ceilings, the furniture, carpets, and hangings are inhabited by them.

The head louse infests particularly the hairs of the head. The eggs are glued to the hairs some distance from the scalp, and this justifies the ancient and simple method of control by clipping the hair very close. When this procedure does not result in complete riddance, a 2 per cent solution of carbolic acid should be applied liberally.

The crab louse infests particularly the pubic region, although it may spread to the chest and other hairy parts of the body, particularly in heavy infestations and in very hairy individuals. This species attaches itself very firmly to the hairs, but does not ordinarily occur in the clothing. On this account it does not spread as readily as the body louse, and it is easily controlled. A single thorough application of mercurial ointment, popularly called blue ointment, is usually effective.

Experiments in detail and on a large scale, carried on among soldiers in billets and trenches, go to prove (1) that the soldier himself is the main source of infestation, (2) that the measures suggested below are of great benefit.

(1) Whenever possible, and as regularly as possible, search the clothing thoroughly for both lice and the "nits" or eggs. If you have discovered that the removal of the white patch which binds the seams at the fork of the trousers does not interfere with comfort, it is well to remove the patch. Special care during the searching for the lice and eggs should be paid to this region.

(2) The great source of danger is the presence of eggs on the clothing. These hatch in about a week. It is necessary, therefore, that the trousers should be ironed and brushed at least once a week.

(3) Against the lice themselves, whenever it is found necessary, use the remedies recommended. Powders, as a rule, should not be used at the fork, but down the shirt and trousers. Care should be taken to see that any powder which falls from the shirt to the fork should be small in amount, as too much is liable to cause smarting. If your stock of ointment (see note below) and powder is exhausted, apply to the man in your unit who is responsible for these preparations.

(4) Just previous to going to the trenches be careful to treat the clothing and body as directed.

(5) Use the preparations about every four days. Experiments in the trenches have shown this to give the best results.

(6) See that any material, blankets, empty sandbags, etc., which may be present to increase the comfort of the dug-out or billet, are treated with the powder preparation.

(7) Take advantage of all the facilities offered at the baths.

N. C. I. (napthalene 96 per cent, creosote 2 per cent, iodoform 2 per cent). This preparation is a speedy killing agent and is the best all-round verminicide tested. The investigator himself prefers it to any other preparation. (A. D. Peacock, M. Sc., Brit. Med. Journal, June 3, 1916, pp. 786–787.)

For practical purposes it has been found that destruction of lice and their eggs is best secured by immersion of verminous garments and bedclothes in a petrol or benzene bath. Danger from fire and waste of petrol are avoided by using such a bath and extractor as are employed in a dry-cleaning apparatus. In such an apparatus 90 per cent of the petrol or benzene is recovered for future use. A petrol or benzene bath is necessary, especially for uniforms and woolen garments generally. Where the clothing is such that it is not injured by immersion in water, steeping the garments for half an hour at 12° C. (54° F.) in a soap solution containing 2 per cent of trichlorethylene or 10 per cent of tetrachlorethane is effective. Steeping for half an hour in a 5 per cent solution of cyllin in water maintained at 65° C. (149° F.) is also effective on woolen articles. For reasons of economy the chlorine derivative of ethane and ethylene can not be used at present in a dry-cleaning process, but their soap preparations are of value. Petrol has a wide application and is readily obtained. For cleansing the body itself, bathing or sponging with soap solutions containing 2 per cent of trichlorethylene or 10 per cent tetrachlorethane gives the best results. In view of the known insecticidal action of these chlorine derivatives of ethylene and ethane, it is probable that good results would be obtained by shampooing verminous heads with their soap preparations, and it is also probable that a 25 per cent solution of trichlorethylene in vaseline would form an efficient insecticidal ointment.

It is almost certain that lice would not continue to live on the human body if anointed daily with a 25 per cent solution of trichlorethylene in vaseline or on the body anointed twice daily with a solution of petrol in vaseline of similar strength. The odor of such ointment is not pleasant, but when living under verminous conditions, constant precautions would have to be taken and every method of destroying vermin would require to be employed. Any attempt to render an army free from vermin in war time would require that all men occupying the same quarters at the same time, or for alternating short periods of time, should be regarded as a single unit for which a receiving station with cleansing apparatus should be provided. Such an attempt would also require that the movements of the men off duty were controlled, and this would be limited by military necessities. (Kinloch, J. P., Brit. Med. Journal, June, 1915).

After examining a number of known remedies, which were all reprepared and tested, the following are considered to be the most efficient and the best adapted to the circumstances of armies in the field: (*a*) 35 per cent cresol and 65 per cent naphtha soap; (*b*) 35 per cent xylol and 65 per cent naphtha soap; (*c*) 5 per cent turpentine, 5 per cent petrol, 2 per cent oil of cinnamon, and 88 per cent talc. The first named is specially useful, as it not only kills the lice and their eggs rapidly, but the odor, which is retained for a long time by the clothing, will keep the lice away for several weeks. A 10 per cent solution in water is recommended, body linen to be soaked in it and all outer clothing well wetted and the mixture rubbed in with a brush. (Soulima [A] and Elbert [B], C. R. Soc. Biol., Paris, LXXVIII, No. 14, June 25, 1915, p. 340.)

The mixture which was most satisfactory consisted of oils of lemon grass, pennyroyal, and eucalyptus, 300 c. c. of each, and powdered naphthalene, 100 grams; the oils evaporate in the order given. Pieces of cloth or felt carrying from 6 to 8 drops of this mixture and fastened to the underclothing at those spots where lice generally congregate will prevent breeding. To cleanse the clothing, ironing the seams and doubled or lined parts with a very hot iron is effective; linings should be wetted with 5 parts of the mixture in 100 parts of alcohol and ironed at once. Military accoutrements should be put into a barrel or other container which can be closed almost hermetically and exposed to the vapor of the mixture at a temperature of from 105° to 112° F.; 5 c. c. per cubic metre is sufficient and the exposure should be for 20 minutes

per cubic metre. Eggs on the hair may be destroyed by an ointment made from 2 cc. of the mixture and 8 grams of vaseline well blended. (Legroux, R. Bull. Soc. Path. Exot. 8, No. 7, 1915.)

Perhaps the best method of destroying both lice and their eggs in clothing is to subject the garments for 20 minutes to the action of steam under pressure. The whole of the clothing must be treated at the same time, and as complete change is not possible in the field, the process fails in practice even when the somewhat cumbrous apparatus can be set up. The author steeped verminous body linen in solutions of cresyl in water at 10. 5 and 3.3 per cent for 10 minutes and hung it in the sun. The result was, in all cases, the death of the lice. Further experiments showed that a 2 per cent solution, freshly prepared, was quite sufficient to kill all lice with which it was in contact for 10 minutes. A quart of cresyl in 12½ gallons of water was enough to kill the lice in the body linen of 62 men, each garment being wrung out to recover the liquor as far as possible. Careful and vigorous brushing of uniforms with a hand brush in the open will rid them of both lice and eggs, which fall on the soil and die. (Legendre [J]. Bull. Soc. Path. Exot., Paris, 8, No. 5, May 12, 1915, pp. 280–283).

THE BEDBUG.[1]

The bedbug, if not rigorously controlled, is often a serious pest in camps and barracks, especially in warm climates, where multiplication is very rapid.

When a camp has become seriously infested, drastic methods must be employed. If cots are used, the most effective method of destroying the bugs is to dip the cots bodily in a vat or tank containing a boiling weak solution of caustic soda. This will penetrate the crevices of the woodwork and folds of the canvas in which the insects find lodgment and destroy both bugs and eggs. The strength of the solution should be about that usually employed in washing clothes and the cots should remain in the vat about 15 minutes. On removal they should be well washed, preferably with a hose, to remove the soda. After rinsing, expose to sun and air until thoroughly dry. This method has been used successfully in the sanitation of the Canal Zone.

Where facilities for such dipping can not be provided, resort may be had to the liberal application of kerosene or benzine to those parts of the cot which might harbor the insects. Folds and seams of tents and cracks in wooden flooring must also receive attention. The intervals between dippings will be suggested by the rapidity with which reinfestation occurs.

For infested houses, fumigation is the only effective method of treatment. The fumes of sulphur may be used at the rate of 5 pounds per 1,000 cubic feet.

FLEAS.

As fleas breed in dirt, it is to be expected that the adobe houses of the Mexican border will be heavily infested, especially where animals have been present.

Bubonic plague is transmitted by fleas. It has been recorded from various ports in Mexico from time to time, and it is possible that the

[1] *Cimex lectularius* L.

troops may come in contact with an infested community. If the fleas are found on the ground, their breeding places may be sprayed with kerosene or crude petroleum. Dressing the ground under houses with a mixture of 20 pounds of air-slaked lime, 3 pounds of sulphur, and 1 pound of pyrethrum, or "buhach," has proven very effective with the dog flea.[1] In buildings, naphthalene crystals or insect powder may be sprinkled on the floors. Fumigation with sulphur fumes is also effective in buildings. Salt water or aqua ammonia will give relief from the bites.

THE CHIGOE.

The chigoe (*Dermatophilus penetrans* Guérin) is a kind of flea and should not be confused with the "chigger" or "red bug." The female penetrates under the skin, usually under the toe nails or in the sole of the foot, and soon becomes very greatly enlarged. Treatment consists in the careful removal of the insect, which should be done as soon as it is detected. Delay is likely to cause infection. The wound should be treated with weak carbolic acid or tincture of iodine, or dusted thoroughly with an antiseptic powder.

TICKS.

A satisfactory treatment of domestic animals infested with ticks is to dip them in arsenical fluids.

The ticks may be best removed from the human body by applying gasoline, petroleum, or vaseline. The spinose ear tick[2] may be removed from the ear by pouring bland oil into the ear or by inserting a small wad of cotton soaked with chloroform. Tick bites may be treated by bathing in very hot water, followed by an application of a strong solution of bicarbonate of soda, which is allowed to dry upon the skin. For severe itching it is sometimes advisable to smear the bites with vaseline which is slightly impregnated with camphor or menthol.

THE STABLE FLY.[3]

The biting stable fly very closely resembles the house fly, but differs from it in its ability to draw blood. It generally breeds in moist straw and hay, and is very annoying to mules, horses, and cattle, and often to man.

This fly is more often a carrier of animal diseases than of human diseases. Aside from the danger of transmitting disease the fly is very troublesome because of its painful bite. Horses and mules often become frantic in their efforts to escape the flies.

Stacked straw which has been wet and partly rotted and hence is no longer available for stock food is a very favorable place for the fly to breed. Such straw should be dried as soon as possible by scattering and either burned or plowed under. The stable fly does not often develop in manure, and where it does it will be controlled by measures against the house fly.

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[1] *Ctenocephalus canis* Curtis. [2] *Ornithodoros megnini* Dugès. [3] *Stomoxys calcitrans* L.

INSECTS WHOSE BITE OR STING IS IRRITATING AND MAY GIVE RISE TO INFECTION.

Various types of venomous insects have not been included under the preceding headings because their attack is not directly connected with the spread of disease, although their bites may cause serious consequences.

THE CONE-NOSE BEDBUG.[1]

Along the Mexican border certain large blood-sucking bugs are sometimes very annoying to man. These insects are about an inch long. They occasionally bite man, the puncture causing much swelling and irritation. They fly only by night. Usually the only treatment required is the application of antiseptics.

SCORPIONS.

Scorpions are found under rocks and logs, especially in moist situations, and were noted in Cuba in 1898 to be attracted to leather goods, saddles, and harness.

The body is prolonged into a long tail, at the tip of which is a curved spine. In stinging, the scorpion strikes by bending the tail forward rapidly, inflicting a painful wound with the spine. Poison is introduced by the sting. As a rule, the sting of scorpions, while painful, does not produce serious consequences.

The treatment is to apply permanganate of potash. Washing and bathing with a weak solution of ammonia may also be tried, and stimulants should be given.

CENTIPEDES.

The centipedes are elongate creatures sometimes reaching 6 inches in length, with many pairs of legs. The centipede is equipped with poison glands at the base of the first pair of legs, which are bent forward so as to be used in holding their prey. These legs terminate in a powerful claw, at the tip of which is the outlet of the poison gland. The poison causes severe pain, accompanied by vomiting, irregular pulse, dizziness, and headache. The proper treatment is to bathe the injured part with a solution of ammonia (1 in 5 or 1 in 10). After bathing apply a dressing of the same alkali, or, if there is much swelling, an ice bag. The surgeon should be consulted without delay.

SPIDERS.

A poisonous spider occurring in the Southwest is commonly called tarantula. This is a very large hairy spider. It lives in a hole in the ground with a trap door, and its method of attack is suddenly to jump and bury its two sharp-pointed mandibles in the flesh.

The usual treatment is to prevent absorption by a proximal ligature, to open the wound by an incision and apply alkaline solu-

[1] *Conorhinus* spp.

tions, such as a weak solution of ammonia or permanganate of potash. The bites of certain other spiders are also quite poisonous, especially a little black spider with a red spot on the abdomen (*Lathrodectes mactans* Fab.).

"CHIGGERS," OR "RED BUGS".[1]

Great annoyance is often caused by the attacks of microscopic creatures known as "chiggers," "red bugs," or harvest mites. Chiggers are most abundant along the borders of streams and along the edges of forests, and one should avoid walking in such places, especially in shady locations. They burrow under the skin and cause itching and inflammation. The irritation naturally leads to scratching the affected parts with the finger nails, thus abrading the skin and causing infection.

Soon after the chiggers bore under the skin a small red spot appears (evidently the mite itself gorged with blood), after which the surrounding surface becomes congested in from 1 to 12 hours after exposure. Prompt treatment is essential. The inflamed spots are apt to be mistaken for hives, rash, or mosquito bites, and neglected until treatment is difficult.

The best preventive is sulphur, and the body should be rubbed carefully with flowers of sulphur. Prompt bathing, with liberal application of soap, will usually give relief.

Affected parts should be bathed with a moderately strong solution of ammonia, about 10 to 20 per cent. To relieve the inflammation alkalies like ammonia and bicarbonate of soda (better known as cooking soda or saleratus) must be used. In severe cases dilute tincture of iodine, followed by carbolated vaseline or a little collodion, may be applied.

If it be found necessary to camp on ground known to be infested with chiggers, the vegetation should be promptly mowed and removed.

WASPS, BEES, AND ANTS.

Among the most severe pains inflicted by insects are those caused by the stings of bees, wasps, hornets, and ants. One of the predominating insects of the Texas border is the so-called Texas harvest ant (*Pogonomyrmex barbatus* Mayr), a large red species which lives in large colonies. The opening to their nests usually consists of a crater of pebbles and the hole itself is quite large. The ants move from these craters in a continuous stream during the sunny part of the day, usually moving along definite paths. When disturbed they fight with vigor. A person accidentally standing in their path will quickly be attacked. The sting is extremely painful.

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[1] *Trombidium* spp.

When colonies of these ants are located in the immediate vicinity of the sleeping quarters it is best to take prompt measures toward exterminating them. The best time to do this is at night. Three ounces of carbon bisulphid poured into the hole at this time will exterminate the colony. Immediately after pouring in the liquid the hole should be stopped up. Another satisfactory method is to place a few pellets of cyanide of potassium in the hole and then pour in a little water. **Cyanide of potassium is a virulent poison and should be handled with great care.**

The best treatment for bee, wasp, and ant stings is first to remove the sting by gentle scraping with a knife. The inflammation may be allayed by the application of hot or cold water, and a 10 per cent solution of carbolic acid may be used as a safeguard against infection.

PROTECTION OF PERSONS FROM INSECT BITES AND INFESTATION.

To summarize briefly the dangers from insect bites, we may state that malaria, yellow fever, dengue, and typhus fever are directly transmitted to men by the bites of insects. The poisonous stings of such insects as bees, wasps, and ants, and of centipedes, tarantulas, and scorpions, may in some cases cause irritation or more serious consequences. The irritation caused by insects which penetrate the skin, such as chiggers and mites, often gives rise to running sores or abscesses. For this reason it is important that every soldier take extreme precautions to protect his person from insect injury. The common insects to which he is accustomed may be the ones most capable of inoculating his body with disease germs. During the daytime it is possible to guard against all but the smallest insect pests, such as those which enter the flesh. Cleanliness of the body is, therefore, one of the most important preventive measures. The use of *corrosive-sublimate soap* lathered on the body, permitting the suds to dry, has proven a very effective general precaution.

Next to keeping the person clean, it is imperative to keep the clothing clean. As has been shown in preceding paragraphs, lice, bedbugs, and fleas are likely to be found in the folds of the clothing. It is perfectly feasible to provide means of disinfecting the clothing by some of the processes described in this bulletin while the men are receiving their baths.

Many of the insects which attack the person work at night. This includes mosquitoes and bedbugs. It is therefore absolutely essential that the men protect themselves with mosquito netting when sleeping. It is also essential that the ground on which the bedding is placed is clean and has not been used for sleeping by louse-infested persons. In some cases it may be advisable to dust the ground with sulphur.

CONTROL OF INSECTS WHICH INJURE OR WORRY ANIMALS.

The animals about army camps are likely to be greatly disturbed by the attacks of flies and ticks. The first essentials, therefore, are to prevent if possible the breeding of noxious insects around the camp. This will necessitate the careful handling of manure, as suggested in a previous paragraph, the draining of stagnant water, and thorough cleanliness around the stable. It is probable that many flies will be present, even with all these precautions. These should be caught by the use of flytraps.

In case of severe attack from biting flies it is often necessary to protect the animals by the use of repellents. This may be applied by means of a dipping vat or small spray apparatus, or by means of a rag or paint brush. Among the substances which are used in repellent mixtures are fish oil, pine tar, oil of tar, crude carbolic acid, oil of pennyroyal, and kerosene. Very few of these mixtures are active for more than a day and they serve only as emergency remedies. Animals infested by ticks or lice may be dipped in a vat containing a mixture made up as follows:

To make a 500-gallon bath provide—

Sal soda	24 pounds.
White arsenic, 99 per cent pure and finely powdered	9 pounds.
Pine tar	1 gallon.

Put 25 gallons of water in a kettle or tank of 40 to 50 gallons capacity, heat to boiling point, and add the sal soda. When this has dissolved add the white arsenic. Then boil and stir for 15 minutes or longer until the white arsenic has entirely disappeared. If intended for immediate use, cool to 140° F. (by addition of cold water if desired). Then pour in the pine tar in a thin stream, while constantly and vigorously stirring the solution. Immediately empty the liquid into the dipping vat, which has already been three-fourths filled with water, and stir thoroughly. After the addition of the remainder of the water and further stirring, the bath is ready for use.

Owing to the poisonous nature of arsenic it is important that proper precautions be observed in the use of this dip in order to avoid possibly serious damage.

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